CLAIMS

What is claimed is:

1. A mass analyzer including:

a. an ion storage device for receiving and storing ions;

b. a means for applying an ion extraction voltage pulse to said storage device to accelerate the ions whereby ions leaving the storage means have mass-to-charge ratio dependent velocities;

c. a field free region through which the ions of different mass-to-charge ratios travel different distances in a predetermined time, and

d. detectors spaced to receive the ions of different mass-to-charge ratios which have traveled different distances in a predetermined time and provide outputs indicative of the mass-to-charge ratio of the received ions.

2. A mass analyzer as in claim 1 including an ionizer for receiving a sample to be analyzed and form the ions which are received by the ion storage device.

3. A mass analyzer as in claim 2 in which the ionizer is selected from the group comprising an electrospray ionizer, matrix-assisted laser desorption ionizer, atmosphere pressure chemical ionizer, glow discharge ionizer, electron impact ionizer and nanospray ionizer.

4. A mass analyzer as in claims 1 or 2 in which the said outputs indicative of mass-to-charge ratios of the received ions are derived from detectors positioned to receive ions of particular mass-to-charge ratios.

5. A mass analyzer as in claims 1 or 2 including a deflector for deflecting ions traveling in said field free region in an orthogonal direction towards said detectors.

6. A mass analyzer as in claims 1 or 2 including means for dissociating or changing the mass-to-charge ratio of said ions in said field free region into product ions so that said product ions travel at substantially the same velocity as their precursor ions and means for applying an orthogonal accelerating voltage pulse to said product ions and precursor ions whereby the unchanged precursor and product ions of different mass-to-

charge ratios travel at different velocities, said detector arranged to detect the unchanged precursor and product ions and providing a mass spectrum in which the mass-to-charge ratios of the product ions and their precursor ions are both identified.

7. A mass analyzer as in claim 6 in which said means for changing the mass-to-charge ratio of said ions includes means for fragmenting, decomposing, reacting with molecules, adduct forming and charge stripping.

8. A mass analyzer as in claim 6 in which the product ions are detected by time-of-flight detectors.

9. A mass analyzer as in claim 6 which includes means for applying an orthogonal field to said product ions to deflect the ions, and said detectors are positioned to enable position dependent detection.

10. A mass analyzer as in claim 6 including means for applying a transverse deflection field to the ion stream after the formation of product ions so that precursor and product ions are separated transversely according to their mass-to-charge ratios.

11. A mass analyzer as in claim 10 in which said means for applying a transverse deflection field is positioned before the orthogonal acceleration region.

12. A mass analyzer as in claim 10 in which said means for applying a transverse deflection field is positioned after the orthogonal acceleration region.

13. A mass analyzer as in claim 10 in which the ions spread axially according to their precursor mass-to-charge ratio and transversely according to their product mass-to-charge ratio are detected using a two-dimensional array of ion detectors.

14. The method of mass analyzing an ion stream which comprises the steps of:

trapping ions in an ion storage device;

applying a longitudinal extraction voltage to the storage device whereby ions having a smaller mass-to-charge ratios travel at a greater velocity than ions of a larger mass-to-charge ratio;

allowing said ions to travel for a predetermined time in a field free region whereby they travel different distances; and

detecting the ions of different mass-to-charge ratio with detectors which are spaced substantially parallel to the line of travel.

15. The method of analyzing a stream of ions of different mass-to-charge ratios which comprises the steps of:

receiving and storing a predetermined number of said ions;

accelerating said stored ions whereby ions of different mass-to-charge ratios attain different velocities; and

determining the mass-to-charge ratios of said ions by the distance traveled by ions of different mass-to-charge ratio in a predetermined time.

16. The method of mass analyzing a stream of ions of different mass-to-charge ratios comprising the steps of:

directing said ion stream to an ion storage means;

periodically applying an extraction voltage to said storage means to extract ions from said storage means with a velocity that is dependent upon the mass-to-charge ratio of said ions;

allowing said ions to travel through a field free region, and

detecting said ions with ion detectors spaced to receive ions of different mass-to-charge ratio which have traveled different distances in a predetermined time.

17. The method of claim 14 which includes the additional step of dissociating said ions in the field free region whereby to form bundles of fragment ions having the same velocity as the precursor ions and thereafter applying a orthogonal voltage pulse to said bundles to cause the fragment ions to attain a velocity which is dependent upon their mass-to-charge ratio and, detecting said fragment ions and providing information regarding their mass-to-charge ratios and that of their precursor ions.

18. A method as in claim 13 in which the fragment ions are detected by detecting their time-of-flight.

19. A method as in claim 17 in which the fragment ions are detected by detecting their distance of travel at a predetermined time after the orthogonal pulse.

20. A mass spectrometer comprising, an ion storage device; an extractor that is configured and arranged to provide an extractor field to extract and accelerate a bunch of ions from the ion storage device to accelerate ions of smaller mass-to-charge ratio at a greater velocity than ones of larger charge-to-mass ratio, a field free region through which the ion bunch travels, a plurality of separate detectors spaced from the acceleration region each by respective distances that differ from each other and; a lateral accelerator configured and arranged to generate a lateral field within the field free region that causes the ions to change their direction of travel laterally to reach adjacent ones of the separate detectors, the separate detectors being configured and arranged to detect ion intensity of the smaller and larger mass-to-charge ratio ions that reach them.

21. A mass spectrometer of claim 20, wherein the separate detectors are arranged parallel to the line of travel.

22. A mass spectrometer of claim 20, wherein the plurality of separate detectors present the ion intensities in reverse order of distance of the separate detectors from the extraction region to produce a mass spectrum.

23. A mass spectrometer of claim 20, wherein each of the separate detectors is configured to accumulate ion charges over a period of time.

24. A mass spectrometer of claim 20, wherein the mass analyzer is configured to operate to store and accelerate in bunches sequentially in time.

25. A mass spectrometer of claim 20, wherein an ion fragmentation cell is within the field free region in the path of the accelerated ion bunch and configured to dissociate said ions to form ion fragments, wherein said lateral accelerator accelerates the ions of smaller charge-to-mass ratio to a greater velocity than the ions of larger charge-to-mass ratio and wherein said detectors are configured to measure the times-of-flight of the ions

after they are laterally accelerated to detect the fragment ions whereby to provide information regarding the [parent and] fragment ions and their precursors.

26. A mass spectrometer of claim 25, wherein the ion dissociation energizes precursor ions of the ion stream by collision with a neutral gas molecule to induce the dissociation.

27. A mass spectrometer of claim 25, wherein the fragmentation cell applies fragmentation energy to the ion stream that avoids substantial momentum transfer to the fragment ions.

28. A mass spectrometer of claim 20, wherein the separate detectors are arranged relative to each other so that a position of each ion's detection has a square root relation to charge to mass ratio of that ion.

29. A mass spectrometer of claim 20, wherein the extraction field generated by the extractor is derived from an extraction voltage that increases in magnitude with time.

30. A mass spectrometer of claim 20, wherein the extraction field generated by the extractor is derived from an extraction pulse whose shape varies.

31. A mass spectrometer of claim 20, further comprising a fragmentation section arranged to fragment the ion stream, an orthogonal time of flight section arranged to sort the ions of the fragmented ion stream according to mass to charge ratio values said detectors arranged to detect time of arrival of the sorted ions.

32. A mass spectrometer of claim 25, further comprising a fragmenter that applies an intense, energetic beam of light, timed to coincide with appearance of ions reaching the fragmentation cell.

33. A mass spectrometer of claim 32, wherein the fragmentation section includes a cell with internal reflecting surfaces.

34. A mass spectrometer of claim 25, including a deflector providing a deflection field to the fragment ions so that they are separated by distance of flight and wherein the

detector array comprises a two-dimensional array to detect arrival of the ions and provide the mass-to-charge ratio of the ion fragments for each ion.

35. A method of ion detection with a mass spectrometer, comprising:

accelerating ions from an ion store by applying an extraction field to cause ions of smaller mass-to-charge ratio to accelerate to a greater velocity than ones of larger charge-to-mass ratio form an ion stream that follows a flight path through a field free region,

laterally accelerating the ion stream within the field free region to reach adjacent ones of separate detectors in a detector array, the separate detectors being spaced from the acceleration region each by respective distances that differ from each other; and

detecting ion intensity with the separate detectors.

36. A method of claim 35, wherein the lateral acceleration arises by applying an electric field directed orthogonal to the flight path.

37. A method of claim 35, further comprising fragmenting the ion stream; sorting the ions of the fragmented ion stream according to mass to charge ratio values; and detecting the sorted ions.

38. A method of claim 36, further comprising arranging the separate ion detectors to provide one mass unit for other specific mass-to-charge ratio resolution by determining separation distances between the separate detectors derived from a relation of position along the flight path with respect to adjacent unit mass to charge ratio values within the range.